Dietary supplement use in adolescents

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Purpose of review

As prevalence rates of dietary supplement use are observed to be increasing in adolescents and the population in general, questions need to be asked about the efficacy, motivations, and consequences of such usage. Focusing mainly on individuals between the ages of 12 to 19 (adolescents) this review will highlight current prevalence rates, types of supplements being consumed, reasons for consumption, and concerns regarding physiological, psychological, knowledge transfer, and regulatory aspects of supplement use.

Recent findings

Studies have indicated the prevalence of dietary supplement usage by adolescents range from approximately 10% to as high as 74%. Some of the highest rates of usage appear in chronically ill adolescents. Multivitamin and mineral preparations are the most common supplements being consumed; however, many studies indicate that adolescents are using other substances like creatine, herbals, or protein supplements. Some of the most appealing supplements among this age group are those that enhance athletic performance or physical appearance. Recent literature suggests three key moderating factors for supplement use in adolescents: health status, gender, and level of physical activity involvement.

Summary

As the dietary supplement industry is now a multi-billion dollar industry, there is growing pressure, and a subsequent need for research to establish the efficacy and safety of these products particularly for adolescent users. The psychological and educational components of such use cannot be ignored as they play an equally important role in the health and safety of adolescents.

Keywords

adolescents, attitudes, dietary supplements, performance enhancement

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Abbreviation

BMI body mass index

1040-8703

Introduction

Recognizing the dramatic increase in knowledge, usage, and availability of dietary supplements, the Office of Dietary Supplements of the National Institutes of Health in the United States held a conference in 2001 to discuss the state of this knowledge [1]. Their discussions revolved around the 'who, what, why, and where do we go from here?' as it pertains to children and adolescents. We will review the recent advances in these areas specifically with respect to adolescents (i.e. those individuals between the ages of 12 and 19 years). We discuss the prevalence of supplement use in adolescents (the 'who'); the most prevalent types of supplements used by adolescents (the 'what'); the reasons cited for use of these substances (the 'why'); and concerns surrounding physiological, psychological, knowledge transfer, and regulatory aspects of dietary supplement use (the 'where do we go from here').

Prevalence of dietary supplement use in adolescents

For the purposes of this review, a dietary supplement will exclude illegal substances like anabolic steroids and will refer to a product (other than tobacco) intended to supplement the diet that bears or contains one or more of the following dietary ingredients: a vitamin, mineral, amino acid, herb or other botanical; or a dietary substance for use to supplement the diet by increasing the total dietary intake; or a concentrate, metabolite, constituent, extract, or combination of any ingredient described above; and intended for ingestion in the form of a capsule, powder, softgel, or gelcap, and not represented as a conventional food or as a sole item of a meal or the diet [1].

Many published studies in the past year examined the prevalence of dietary supplement use in the United States [2••,3•,4•,5••,6] with a few in other countries [7••,8•,9–11]. National longitudinal studies like the National Health and Nutrition Examination Survey provide valuable information of a cross-section of American residents regarding the prevalence of dietary supplement use across the lifespan. According to these surveys, usage of dietary supplements in the general adult population (age 20+) has increased over a 30-year period but at the same time decreased in children aged 1 to 5. Use in the general youth and adolescent population has remained constant at approximately 24% and 29% over this same period [4•].

Reports of usage in the general adolescent population stay consistent; however, studies that involve somewhat smaller samples of high school students often describe varying levels of supplement use. For example, studies of usage

among high school students have ranged from 10.1 [8•] to 74% [5••]. One of the consistent findings among these studies is the positive correlation found between supplement use and level of physical activity involvement.

Types of supplements used

The most common forms of dietary supplements being used are multivitamin, or individual vitamin/mineral preparations (particularly vitamin C). Some studies suggest that adolescents are also using ergogenic aids such as creatine, protein supplements, or herbal products like ginseng or ephedra. Gender differences in types of dietary supplements are apparent. For example, male adolescents have a tendency to use more ergogenic aids (i.e. substances that allege to enhance athletic performance); female adolescents are more prone to use herbal and weight control products.

Reasons for supplement use

The most commonly cited reasons for usage are to maintain or improve health, to increase energy, to build muscle or increase weight, to decrease body fat or weight loss, to increase athletic ability, to help heal injury or illness, or because of an inadequate diet [2••,5••,12]. It seems that the reasons adolescents are giving for using supplements are consistent with the types of supplements being used. Although it may be commendable that supplements are being used to maintain or improve health, it is somewhat disconcerting that supplements are also being used in an attempt to enhance athletic performance or physical appearance.

Over the course of the past year, a few studies were identified that focus specifically on the use of supplements for health reasons or for reasons of performance or body enhancement. Some of the key points from those studies are discussed below.

Health reasons

Contained within the growing utilization of complementary and alternative medicines in today's society is the use of dietary supplementation particularly by those with chronic, sometimes incurable, medical problems. Studies of children and adolescents with such medical conditions as atopic dermatitis [13], asthma, type 1 diabetes mellitus, solid tumor cancer, leukemia, renal or liver transplantation, seizure, rheumatoid or neurobehavioral disorders (attention-deficit hyperactivity disorder, Down syndrome, and autism), and cystic fibrosis [14••] have found usage rates to range from 41 to 98%, somewhat higher than the rates reported from the general population.

As reported by Ball, Kertesz, and Moyer-Mileur [14••], the greatest use of dietary supplements was by children and adolescents with cystic fibrosis (98%); individuals with leukemia reported the lowest use (46%). Vitamin and mineral preparations were the most common type of supplement being used, with a reported 100% of individuals with cystic fibrosis complementing their diet with some form of vitamin preparation. When questioned about the reasons why supplements were being added to the diet, the most common responses by the parents of these children were to improve general health, to supplement the diet, and to prevent disease. An interesting finding of this study was that approximately 66% of the total number of parents surveyed indicated that they had supplied their children with some form of supplement; however, approximately 33% of parents reported a discontinuation of use. Reasons for discontinuing usage included the supplement was no longer required; the child's physician had advised against use; there was a lack of perceived benefit; the child did not like or tolerate it; or it was too expensive.

Performance or body enhancement reasons

Given the growing number of studies that suggest increases in the rates of obesity [15], dieting practices [16], and attempts to lose weight [17] among adolescents, coupled with society's infatuation with the 'win at all costs' mentality, the number of adolescents who use dietary supplements in an attempt to succeed is perhaps not surprising. Many studies in the past year reviewed or examined the efficacy of various types of supplements said or believed to enhance performance [18•,19–22], yet few mention the impact of these substances on adolescents. Of those that did examine the effects of supplementation on adolescents specifically, two focused on creatine [23••, 24•], one on iron [25•], and one on vitamin-mineral [26•] supplementation in an athletic context. The main findings from each of these studies are presented in Table 1.

There is some evidence to suggest that some types of dietary supplements are beneficial in enhancing performance. One study examined adolescents' beliefs regarding the performance-enhancement capabilities of dietary supplements. Bell *et al.* [7••] found most adolescents in their sample believed multivitamin and mineral preparations, creatine, and protein supplements would enhance performance, and weight management products would decrease performance. There was a great deal of uncertainty regarding the ability of other supplements (e.g. L-carnitine and diuretics) to enhance performance. Another interesting finding from this study was the positive performance-enhancing beliefs held by individuals who participated in exercise and sports. This uncertainty is particularly disturbing as it may lead to these individuals being more susceptible to misinformation and subsequent future use of a potentially harmful substance. Furthermore, the belief in the efficacy of a supplement may be a detriment to psychological health if it removes the sense of personal efficacy for change or performance improvement and instead encourages attributions of success to be placed on an external aid.

Table 1. Summary of studies examining supplement use in a sport context

Authors	Supplement studied	Participants	Sport	Main findings
Ostojic [23••]	Creatine	20 males; mean age 16.6 years (±1.9 years).	Soccer	• No effects on endurance trials were seen; No adverse short-term effects of acute supplementation
Mero, Keskinen, Malvela, & Sallinen [24•]	Creatine & sodium bicarbonate (CrSB)	8 males, 8 females; mean age 17.8 years (±0.7 years).	Swimming	• CrSB may be useful when performing repeated bouts of maximal interval swim sprints (1 min or less).
Tsalis, Nikoladis and Mouglos [25•]	Iron (food intake and supplement)	21 males, 21 females; aged 12–17 years (nonanemic)	Swimming	• High-iron intake either by diet or supplementation did not significantly alter iron status or performance parameters
Cavas and Tarhan [26•]	Vitamin–mineral	15 males, 15 females; mean age 12.1 years (±1.7 years)	Swimming	• Vitamin–mineral supplementation may be useful to attenuate the muscle damage markers, enhance antioxidant status, and reduce lipid peroxidation that occurs in response to 1 month strenuous swim training.

Concerns regarding the use of dietary supplements

The concerns regarding the use of dietary supplements can be grouped into four categories: physiological, psychological, issues related to the dissemination and transfer of knowledge regarding supplements, and regulation and standardization of these products.

Physiological concerns

The literature documenting the clinical evaluations of prevalence, efficacy, and safety of the use of dietary supplements in adolescent populations is somewhat scarce in comparison to these issues in adults. This is especially true with respect to supplements other than vitamin and mineral preparations. The physiological and metabolic differences between adolescents and adults would suggest that these supplements would be absorbed and excreted in different ways. Therefore, supplements that appear to be safe and effective in adults may have unpredictable adverse effects in younger populations. Even though this concern was highlighted by the National Institutes of Health Office of Dietary Supplements conference discussed earlier, little research seems to have been published since that time that addresses the specific physiological and metabolic circumstances of adolescent users.

Psychological concerns

There is a paucity of research on dietary supplement use from a psychological perspective. Two recent studies attempted to fill this gap by examining the intentions of adolescents to use dietary supplements in the future. It was encouraging to see that adolescents who reported they would not use (24.3 to 82.2%) the supplements examined by Bell *et al.* [7••] outnumbered the ones who reported they would use (0.6 to 13.2%) these supplements in the future. The enthusiasm from this finding is somewhat dampened however, when the number of adolescents who stated they were unsure about whether or not they would use them in the future is considered (14.6 to 41.9%). It seems that, similar to the findings regarding beliefs about the performance-enhancing effects of supplements, there is a great deal of uncertainty with respect to potential supplement use. The fact that adolescents are unsure about the effectiveness of supplements and that this ambiguity could have an impact on their willingness to use these substances in the future is a cause for concern and an area that requires future research.

Complementing the findings of Bell *et al.* [7••], Lucidi *et al.* [8•] found the strongest predictor of intentions to use supplements (and illegal doping substances) were the adolescents' attitudes towards these products. These researchers also showed the importance of social norms and pressures from salient individuals and past use of ergogenic aids towards the intention to use illegal substances (e.g. anabolic steroids, growth hormone, erythropoietin, testosterone, and stimulants) in the future. Even though this research revolved around the use and intention to use more illegal doping substances, the relation between past ergogenic aid use and the willingness to use illegal substances in the future is worrisome. This concern revolves around the potential for dietary supplements to act as a 'stepping stone' or 'gateway' [27] to illegal or more harmful types of substance use – a pattern that is observed in other types of substance abuse such as alcohol, tobacco, and marijuana [28]. Although there is a substantive body of research on the gateway concept with respect to adolescent drug use, the potential role of dietary supplements remains to be clarified.

Knowledge transfer

Adolescents are getting their information regarding dietary supplements from strength coaches, friends, fellow athletes, physical trainers, family members, the media, the

Internet, physicians, and dietitians [2••,5••,12,14••,29]. The accuracy of nutritional information from some of these sources is often impossible to determine. As a result, much of the education and role modeling adolescents receive may be inaccurate, incorrect, or indeed, potentially harmful.

Greater knowledge of nutrition is associated with lower rates of supplement use [30], thus the more accurate education adolescents receive the better, especially in light of the discussion earlier regarding the uncertainty of future behaviors. Although specific to slightly older, university-aged students, Burns, Schiller, Merrick, and Wolf's [29] study of dietary supplement use, efficacy, and primary information sources highlights the need for sports nutritionists or dietitians as part of the athletic team. The prevalence of athletes using dietary supplements and their heavy reliance on athletic trainers who may or may not have any formal nutrition training indicates that this is a much-needed area of attention.

Even when physicians are the source of information does not negate some of the issues associated with supplementation. Few studies examine what physicians are telling or asking their patients about dietary supplements [2••]. Some reports show that approximately 76% of physicians believe their patients or parents of their patients would advise them of supplement use [2••]. Other reports asking the parents themselves indicate that only 20% had actually discussed supplementation with the physician [14••]. This information is particularly troublesome because of the possibility of drug–herb interactions. Parents and adolescents need to seek the guidance of experts when deciding to use these products. Similarly, physicians need to be aware of and ask about these practices.

Regulation

The dietary supplement business has grown to a multibillion dollar industry within the past decade [4•]. However, manufacturers of dietary supplements in North America are not forced to prove the safety, efficacy, purity, or potency of their products. This leads to safety concerns associated with contamination, label and product discrepancies, lack of standardization and testing, and the potential for adverse effects. Most evidence of adverse effects in adolescents is anecdotal; the World Health Organisation suggests that most cases are not caused by the supplement itself, but by their contaminants [2••].

Conclusion

Several studies fell outside the scope of this review, mainly because the research focused on the dietary intake of adolescents without examining supplement use. A growing number of studies however, examine supplementation and its efficacy in young adults (i.e. 19 to 24 years). An extension of this research to adolescents may serve to address some of the gaps existing at present in our knowledge of adolescent supplement use.

Two key areas for future research are:

(1) The long-term effects of supplement use in adolescents. Most studies investigating the safety of products tend to employ short-term supplementation interventions and may not be reflective of the long-term use of these products. The Dortmund nutritional and anthropometric longitudinally designed (DONALD) study [10] provides an example of how longitudinal, population-based studies can increase our understanding.
(2) The psychological antecedents and consequences of supplement use in adolescents, taking into account gender differences. Some studies have identified a gender difference in supplement use [7••,12]; however, more research is needed to confirm these trends.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

1 National Institutes of Health. National Institute of Child Health and Human Development. NIH Conference: Dietary supplement use in Children: Who, what, why, and where do we go from here – Executive summary. [Online]. 2004 [cited 2005May 1]; Available from: URL:http://www.nichd.nih.gov/about/od/prip/pastevents/executive_summary.htm

2 •• Gardiner P, Dvorkin L, Kemper KJ. Supplement use growing among children and adolescents. Pediatr Ann 2004; 33:227–253.
This review focuses on the epidemiology of pediatric dietary supplement use, its safety and efficacy, and the attitudes of parents with children who have acute or chronic diseases and physicians to dietary aids.

3 • Ervin RB, Wright JD, Reed-Gillette D. Prevalence of leading types of dietary supplements used in the third National Health and Nutrition Examination Survey. 1988–1994. Adv Data 2004; 349:1–8.
Prevalence data for the most commonly used dietary supplements from a wide range of age groups is reported for the US population.

4 • Briefel RR, Johnson CL. Secular trends in dietary intake in the United States. Annu Rev Nutr 2004; 24:401–431.
A review the information from four NHANES from 1971 to 2000.

5 •• Herbold NH, Vazquez IM, Goodman E, Emans SJ. Vitamin, mineral, herbal and other supplement use by adolescents. Top Clin Nutr 2004; 19:266–272.
This is a comprehensive survey of high school students' supplement use, their attitudes to supplements, their sources of information, and their physical activity levels. A wide range of traditional and nontraditional supplements is identified. The effects of gender, body mass index, and sport participation on the reported reasons for supplement use are also examined.

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7 •• Bell A, Dorsch KD, McCreary DM, Hovey R. A look at nutritional supplement use in adolescents. J Adolesc Health 2004; 34:508–516.
This study contributes to the literature in this area via its examination of factors contributing to supplement use, potential use, and adolescent knowledge and beliefs about dietary supplements. Key factors associated with use, such as the specific effects of gender, age, and level of physical activity on choice of supplement are also identified.

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This is one of the few studies to provide a theoretical framework for the observed use of nutritional ergogenic aids and doping substances in a sample of adolescents.

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This questionnaire-based study of supplement use in chronically ill children extends the research from its predominant focus on healthy children and adolescents to those whose health is compromised in some way. Key concerns are highlighted such as the extent to which pediatric healthcare providers' are aware of supplement use in this population.

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This is a good review of select nutritional supplements and the science and safety behind their proposed ergogenic effects.

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The effect of creatine monohydrate supplementation in male adolescent soccer players is examined. This study extends the literature on the effects of creatine to adolescents and its potential impact on sport-specific performance skills. Unlike many other studies, the authors highlight the importance of increasing education rather than recommending supplement use as a means to enhance performance.

24 • Mero AA, Keskinen KL, Malvela MT, Sallinen JM. Combined creatine and sodium bicarbonate supplementation enhances interval swimming. J Strength Cond Res 2004; 18:306–310.
The authors detail a double-blind crossover trial of the potential ergogenic effects of a creatine-sodium bicarbonate combined supplement on the swim performance of adolescent swimmers. The possibility of ergogenic effects being afforded by different metabolic pathways is examined.

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